FULL REVIEW

Full Review: Newton's Laws and Free-Body Diagrams

Build Newton's laws from interactions and free-body diagrams: choose the system, identify external forces, and connect net force to changes in motion.

◷ TIME	◎ BEST FOR	✓ FINISH WITH
45–60 minutes	A complete unit review	A readiness check

After this full review, you'll be able to…
explain how forces arise from interactions, draw disciplined free-body diagrams, and use net force to predict how motion changes.

HOW TO USE THIS GUIDE

Work through the stages in order. Write directly in the spaces provided, check your work in the Solutions section, and finish by choosing the next resource that matches your confidence.

Choose how you want to review: work through this guide, follow the online review, or watch the video review.

Start the Review Online →
Watch the Video Review →

YOU WILL NEED

Pencil or pen • Calculator if needed • Approximately 45–60 minutes

FR-02 • UNIT ALIGNMENT

Unit Alignment

This bundle is aligned to the approved Physics Sensei unit specification below. Use it to recover the unit structure, reinforce key decisions, and confirm readiness for the next study task.

ARCHITECTURE: Physics Sensei Independent Mechanics UNIT: MEC-U05 — Newton's Laws and Free-Body Diagrams SCOPE: Unit Review PHYSICS LEVEL: Foundational	BEST USED ✓ When force diagrams feel confusing ✓ Before Newton's-law homework ✓ When you want the physical model before the algebra

Review Prerequisites →

FR-03 • YOUR REVIEW PLAN

Your Review Plan

Complete these six stages in order. Each stage builds on the previous one and prepares you for the final readiness check.

6 stages • Approximately 45–60 minutes

PRINTING TIP

For student copies, print double-sided and keep the Solutions section after the student activities so learners attempt each activity before checking their work.

FR-04 • STAGE 1 OF 6

Warm-Up Check

Before you begin, take a moment to see what you already remember. Do not worry about getting everything right. This is only a starting point.

ACTIVITY 1

Recall Activity 1

Isolate one object before naming forces.

A book rests on a horizontal table. Name the external forces acting on the book and state whether the net force is zero.

ACTIVITY 2

Recall Activity 2

Connect unbalanced force to acceleration.

A cart is moving to the right. Its forces suddenly become unbalanced with a net force to the left. What direction is its acceleration? Must it immediately move left?

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Recall Activity 3

Keep action-reaction forces on different objects.

Your hand pushes on a wall. What force completes the Newton's-third-law pair?

Ready to strengthen your understanding?

You've refreshed what you already know. Next, reinforce the essential concepts that will help you solve problems with confidence.

Continue to Core Concepts — page 6 →

FR-05 • STAGE 2 OF 6

Core Concepts

Let's rebuild the key ideas one step at a time. Focus on understanding the relationships before worrying about solving problems.

KEY CONCEPT 1

A free-body diagram begins with the system, not with equations

Choose the object or system first. Draw only forces exerted on that system by objects outside it. Label force type and direction; do not include motion arrows as forces.

$$\Sigma F_{ext} = ma$$

EXAMPLE A book on a table has weight downward and a normal force upward. If a hand pushes the book sideways, that applied force is added to the book's diagram.

SENSEI NOTE Ask 'who exerts this force on my system?' for every arrow. If you cannot name the interaction partner, reconsider the force.

KEY CONCEPT 2

Net force determines acceleration

Newton's second law says the vector sum of external forces determines acceleration. Balanced forces mean zero acceleration, which can mean rest or constant-velocity motion.

$$F_{A\to B} = -F_{B\to A}$$

EXAMPLE If a 20 kg sled has 70 N right and 30 N left, the 40 N net force points right, so the acceleration points right.

SENSEI NOTE Do not confuse zero net force with zero velocity. A puck can move steadily while its forces balance.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Newton's third law organizes interactions

Every force belongs to an interaction pair: A pushes B and B pushes A with equal magnitude and opposite direction. The pair acts on different systems. Contact forces such as normal force and friction depend on the interaction, not on a memorized value.

overturning moment = restoring moment

EXAMPLE Earth pulls a falling ball downward; the ball pulls Earth upward with the same gravitational force. Their accelerations differ because their masses differ enormously.

SENSEI NOTE The normal force is not automatically equal to weight, and friction is not automatically μN; first determine the actual contact situation.

Ready to apply these ideas?

You've reinforced the essential concepts. Now put them into practice by working through guided examples and building your problem-solving confidence.

Continue to Guided Practice — page 8 →

FR-06 • STAGE 3 OF 6

Guided Practice

Now it's time to apply what you've reviewed. Work through each activity in order. The examples become gradually more challenging, and each prepares you for the final readiness check.

PRACTICE 1

Worked Example

Use the force picture before calculating.

A 20 kg sled is pulled horizontally with 70 N while friction is 30 N opposite the motion. Find the net force and acceleration.

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Guided Problem

Recognize balanced forces during motion.

A 60 kg rider in an elevator moves upward at constant speed. What is the rider's acceleration, and what normal force does the floor exert? Use $g = 9.8\ m/s^2$.

PRACTICE 3

Independent Problem

Combine interaction forces on one system.

Two students push a 25 kg cart. One pushes 45 N right and the other 20 N left. Ignore other horizontal forces. Find the cart's acceleration.

Ready to check your understanding?

You've practiced the essential skills with guidance. Now solve a few short problems on your own and confirm you're ready to move forward.

Continue to Confidence Check — page 10 →

FR-07 • STAGE 4 OF 6

Confidence Check

You've rebuilt the key ideas and practiced them with guidance. Now try these short questions on your own to check your understanding before moving on.

QUICK CHECK 1

Balanced does not mean stopped

Interpret zero net force.

A hockey puck slides at constant velocity on nearly frictionless ice. What is the net force on it?

QUICK CHECK 2

Normal force

Use the actual contact situation.

A 5.0 kg book rests on a table while a hand pushes downward on it with 15 N. What normal force does the table exert? Use $g = 9.8\ m/s^2$.

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Third-law reasoning

Choose the force on the other object.

A truck collides with a small car. During the collision, which vehicle experiences the larger interaction force?

HOW DID IT GO?

I answered ____ of 3 questions correctly.

Use the Solutions section to check your reasoning, then take one final look at the essential ideas.

You've checked your understanding.

Take one final look at the essential ideas before deciding what to do next.

Continue to Summary — page 12 →

FR-08 • STAGE 5 OF 6

Summary

Before moving on, take one final look at the most important ideas from this review.

KEY TAKEAWAY 1

Choose the system first

A correct free-body diagram shows external forces on one defined system, each tied to a real interaction.

KEY TAKEAWAY 2

Net force controls acceleration

Balanced forces give zero acceleration; an unbalanced net force points in the acceleration direction.

KEY TAKEAWAY 3

Third-law forces act on different objects

Equal-and-opposite interaction forces do not cancel on a single-object free-body diagram.

MY ONE-SENTENCE SUMMARY

In my own words, the most important idea is:

Ready for your next step?

You've reviewed the essential ideas one last time. Now choose the resource that best matches how confident you feel.

Continue to Next Step — page 16 →

ANSWER KEY • CHECK AFTER ATTEMPTING

Solutions and Explanations

Use these solutions to check your reasoning—not only your final answer. Replace each placeholder with a concise answer and the essential explanation.

WARM-UP • ACTIVITY 1

Recall Activity 1

Weight downward and the table's normal force upward; the net force is zero.

WHY IT WORKS The book has zero acceleration, so its external forces balance. The normal force is a contact interaction from the table; weight is the gravitational interaction with Earth.

WARM-UP • ACTIVITY 2

Recall Activity 2

Its acceleration is left. No; it can continue moving right while slowing down.

WHY IT WORKS Newton's second law links net force to acceleration, not directly to velocity. A leftward acceleration can reduce an existing rightward velocity before reversing it.

WARM-UP • ACTIVITY 3

Recall Activity 3

The wall pushes on your hand with an equal-magnitude force in the opposite direction.

WHY IT WORKS The two forces belong to one interaction but act on different objects, so they never cancel on a single free-body diagram.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Worked Example

Net force = 40 N right; acceleration = 2.0 m/s² right.

WHY IT WORKS The horizontal forces are 70 N right and 30 N left, so ΣF = 40 N right. Newton's second law gives $a = \Sigma F/m = 40/20 = 2.0$ m/s².

PRACTICE 2

Guided Problem

Acceleration = 0; normal force = 588 N upward.

WHY IT WORKS Constant velocity means zero acceleration, so the net vertical force is zero. Therefore $N = mg = (60)(9.8) = 588$ N.

PRACTICE 3

Independent Problem

1.0 m/s² right.

WHY IT WORKS The net force is 45 - 20 = 25 N right. Then $a = 25/25 = 1.0$ m/s² right.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Balanced does not mean stopped

Approximately zero.

WHY IT WORKS Constant velocity means zero acceleration, so Newton's second law requires approximately zero net force.

QUICK CHECK 2

Normal force

64 N upward.

WHY IT WORKS Vertical acceleration is zero. The table must balance both weight (49 N) and the extra 15 N downward push, so N = 49 + 15 = 64 N.

QUICK CHECK 3

Third-law reasoning

Neither; the forces have equal magnitude and opposite direction.

WHY IT WORKS Newton's third law fixes the interaction-force magnitudes. The smaller car can have the larger acceleration because $a = F/m$.

READINESS GUIDE

3 correct: You're ready to continue. • 2 correct: Review the missed idea, then continue. • 0–1 correct: Revisit Core Concepts or choose more practice.

FR-09 • STAGE 6 OF 6

Next Step: Continue Learning

Great work! You've completed this review. Choose the next resource that best matches how confident you feel.

?	◎	✓
I'm Still Unsure	**I Need More Practice**	**I'm Ready**
Review the key ideas and examples again.	Continue with additional practice for this unit.	Continue to the next recommended resource.
Review again: return to Warm-Up Check on page 4.	**Go to Practice →**	**Continue →**

RECOMMENDED LINKS

Review again: return to Warm-Up Check on page 4.

Find additional practice →

Choose another type of physics help →

Continue reviewing with these companion resources.

Start the Review Online →
Watch the Video Review →

PHYSICS HELP THAT MAKES SENSE

A Physics Sensei review never ends at the last question. It always guides you toward the next useful step.

PhysicsSensei.com